Redmond
ARES

City of Redmond
WASHINGTON

Planning an Emergency Broadband Data Network

Red.E.Net

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Topics

- Incentive for project – "Why Red.E.Net?"
- Pilot Phase (2016)
- Results and PSE Grant
- Red.E.Net Phase 1 – 2017 Project Tasks and Timeline
- HamWAN Connectivity Challenges

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Why Red.E.Net?

- Cascadia Rising and other exercises have shown ECC and First Responder efforts are severely impacted when “normal” comms and networks are lost/degraded.
  - Dependence on intranet networks for email, docs and forms
  - Use of WebEOC and other incident command SW applications
  - VOIP phone usage is now standard
  - Trunked LMR systems are spread over wider areas
- VHF and UHF packet technologies can’t handle the necessary speed and data loads
  - Outpost, WinLink, AirMail – text-only message apps using PC and TNC/Radio
  - Functionally equivalent to a half-duplex 1200 bps modem on a simplex channel

(File Size in Bytes **X** 8 bits per Byte)
--- = **Tx time (sec)***
1200 bits-per-second

* And this doesn’t account for protocol overhead – which makes it worse!

- Just for fun – how long to send a 1.5MB smartphone camera pic via Outpost?
  - All other stations wait during TX!!
  - (1.5 MB x 8 b/B) / 1200 bps = 10,000 sec = 2.77 hours!!!!!
- *Everyone remember the WinLink node lockups during CR?*

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Why Red.E.Net?

- ARES/RACES voice nets will be inundated with tactical traffic
  - Formal message traffic?? ICS-213's?? Yeah, right…..
  - A method to compress reports/requests into easy formats for quick transmission is IMPERATIVE!
  - ECC and IC staff need to use systems and forms they are used to – i.e. email, file sharing, phones
- Together these facts all drive the need for a broadband data network solution
  - Broadband: "A wide bandwidth data transmission with an ability to simultaneously transport multiple signals and traffic types." - Wikipedia
  - Implies simultaneous, high-speed, asynchronous and seamless transmission
  - VHF/UHF don't have bandwidth for megabit speeds – 12.5KHz to 25KHz only
  - Megabit speeds require megahertz channels…
- Use 33cm (902-928 MHz) and 5 GHz (multiple 20MHz channels)

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Red.E.Net Pilot Team

CityofRedmond
WASHINGTON

Janeen Olson KE7RWJ – Redmond OEM Volunteer Liaison

Ed Morin WB7UBD – Project Leader

Patrick Kelley K7KEL – Grant Writer/Budget Manager

Charles Beckmeier W7CEB

John Boal K9JEB

Rick Commo K7LOG

Greg Randall N7AHE

John Roberts KG7SQP

Alex Vdolek WA7EDZ

Larry Viesse W7PAN

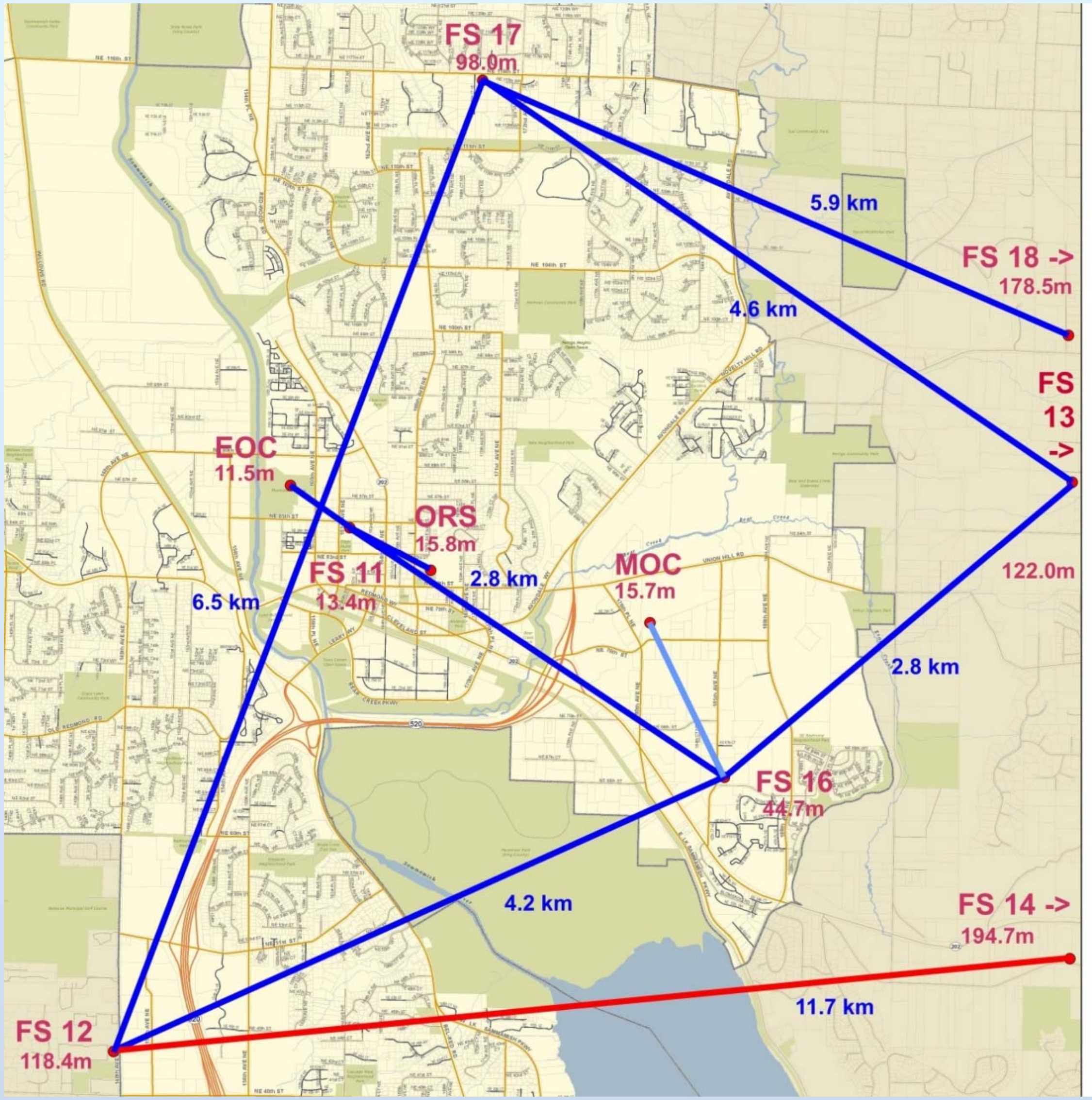
Pilot Phase

- Feasibility Study
  - Terrain analysis: lots of challenges from hills, trees, buildings, elevations
  - High ambient noise floors in high-tech Wi-Fi usage areas
  - Site surveys of fire stations, municipal offices
  - Path analysis run on all possible links
  - Locate sites that can support a HamWAN connection for Internet access

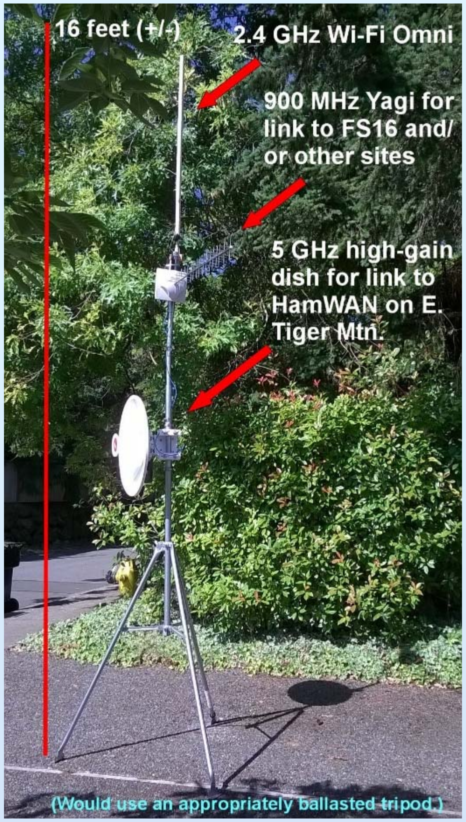
- Objectives
  - Survey sites and identify link challenges (LoS and band)
  - Identify priorities for deployment: ECC, MOC, select FS's
  - Obtain test equipment setups for 900MHz and 5GHz for link testing
  - Run link testing to determine typical speed and throughput performance
  - Develop initial network design for testing and optimization
  - Develop necessary equipment list and budget for deployment

Pilot Phase

- Potential Paths



Pilot Phase



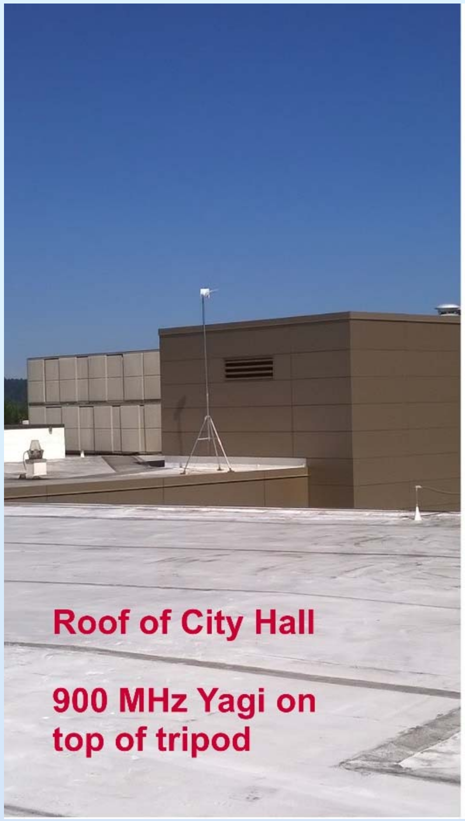
16 feet (+/-)

2.4 GHz Wi-Fi Omni

900 MHz Yagi for link to FS16 and/ or other sites

5 GHz high-gain dish for link to HamWAN on E. Tiger Mtn.

(Would use an appropriately ballasted tripod.)

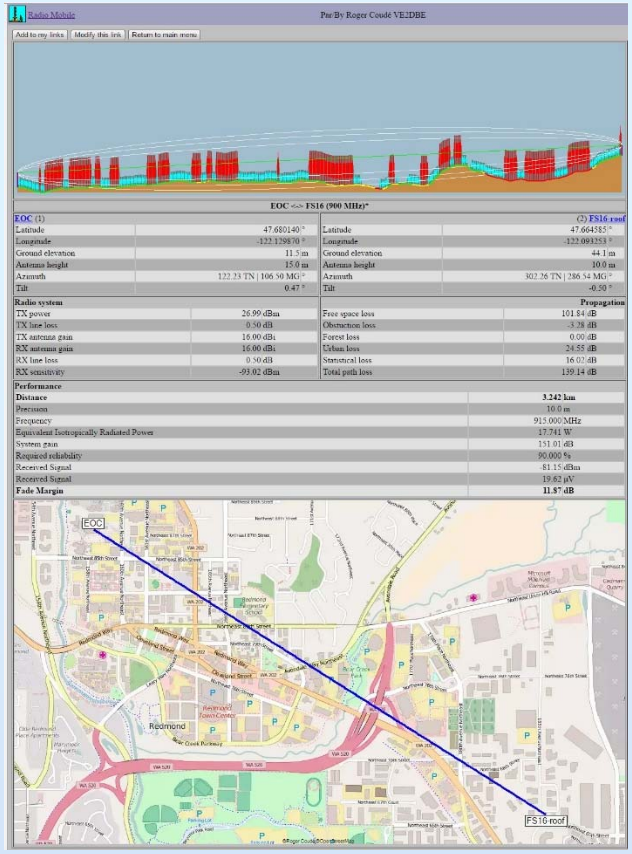


Roof of City Hall

900 MHz Yagi on top of tripod

Behind FS16 across the street from the Water Tank

Results

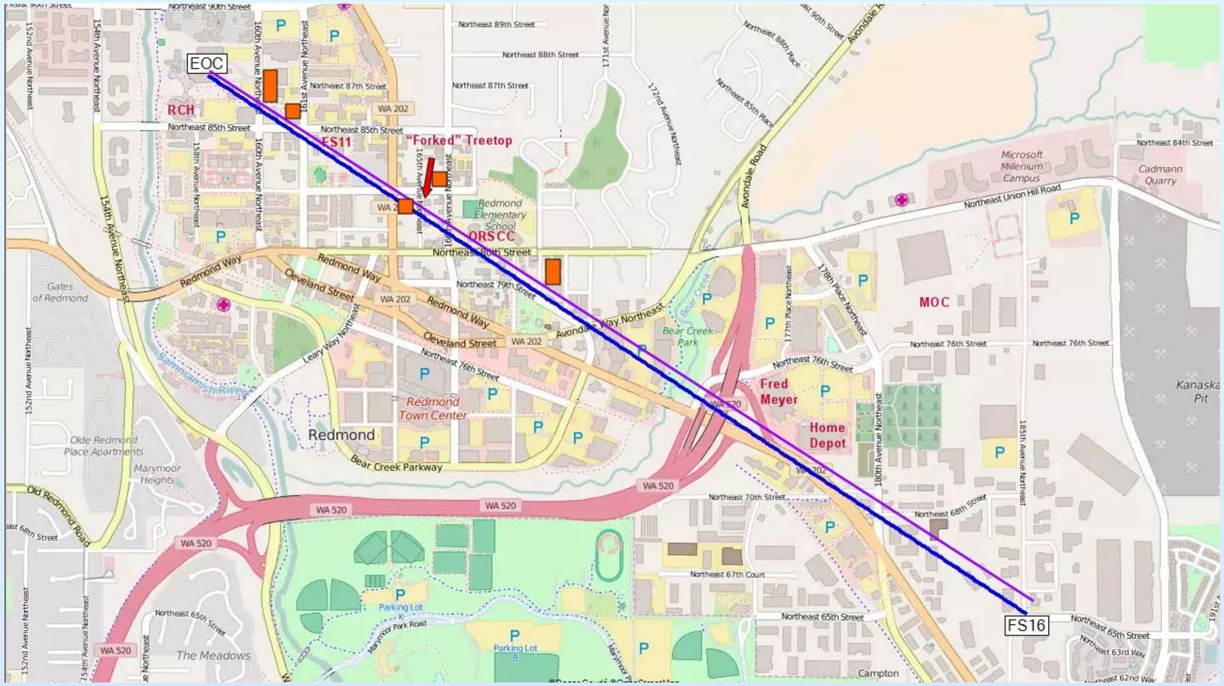


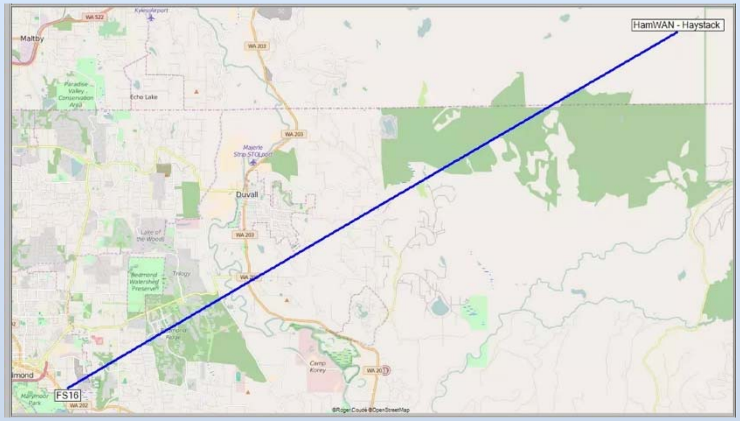
EOC <-> FS16 (900 MHz)*

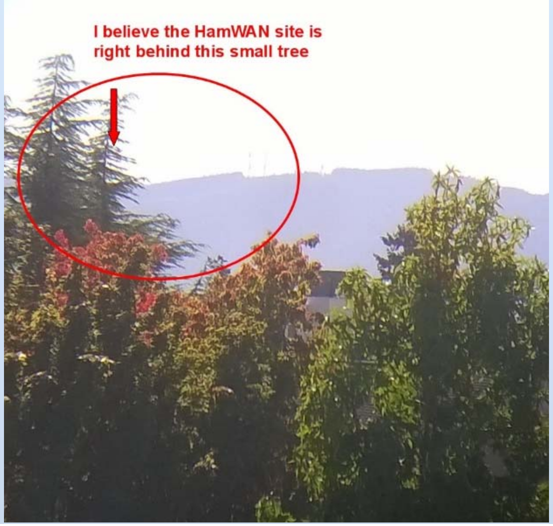
EOC (1)		(2) FS16-roof	
Latitude	47.680140 °	Latitude	47.664585 °
Longitude	-122.129870 °	Longitude	-122.093253 °
Ground elevation	11.5 m	Ground elevation	44.1 m
Antenna height	15.0 m	Antenna height	10.0 m
Azimuth	122.23 TN | 106.50 MG °	Azimuth	302.26 TN | 286.54 MG °
Tilt	0.47 °	Tilt	-0.50 °

Radio system		Propagation	
TX power	26.99 dBm	Free space loss	101.84 dB
TX line loss	0.50 dB	Obstuction loss	-3.28 dB
TX antenna gain	16.00 dBi	Forest loss	0.00 dB
RX antenna gain	16.00 dBi	Urban loss	24.55 dB
RX line loss	0.50 dB	Statistical loss	16.02 dB
RX sensitivity	-93.02 dBm	Total path loss	139.14 dB

Performance	
Distance	**3.242 km**
Precision	10.0 m
Frequency	915.000 MHz
Equivalent Isotropically Radiated Power	17.741 W
System gain	151.01 dB
Required reliability	90.000 %
Received Signal	-81.15 dBm
Received Signal	19.62 µV
Fade Margin	**11.87 dB**







I believe the HamWAN site is right behind this small tree

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Results – 900 MHz

Activity	Result / Status
Focused on a RCH/EOC to MOC link via FS16	Great success => 2 – 5 Mbps. Of particular interest is that the FS16 to MOC link was "off axis" testing the concept of sharing the antenna for the RCH / EOC link.

Goal	Notes
Implement link between ECC and MOC	Still some tests and tasks to finish. Proposal needs to be drafted.
Achieve success on longer-distance link paths	Need to do better than 3.2 km. Average required station-to-station path is about 5.5 km; max is nearly 12 km!
Gain more confidence in the path profiling and analysis tools we're using	Continue to compare predicted vs. real-world results and understand differences.
Train other ARES members how to set up ad-hoc links	Similar to Derby Days demo. Ad-hoc link capability will likely be extremely important during emergency situations when fixed locations are down.

Results – 5 GHz & HamWAN

Activity	Result / Status
Tested HamWAN link at City Hall (RCH)	Not so successful, not sure why yet… ☹

Goal	Notes
Would like to find a clear LOS station-to-station path for a 5 GHz link test.	Theoretically could be MUCH faster than using 900 MHz.
Learn more about how to work with the Mikrotik radios	Although they are good quality, they are much more complicated and less user-friendly than the Ubiquiti gear.
Begin to develop a database of “HamWAN-able” locations for ad-hoc network use.	As noted in the 900 MHz goals, ad-hoc networks could prove to be vital. We need to continue expanding our knowledge and experience base.
Train other ARES members how to set up ad-hoc HamWAN links.	Flexibility, flexibility, flexibility…

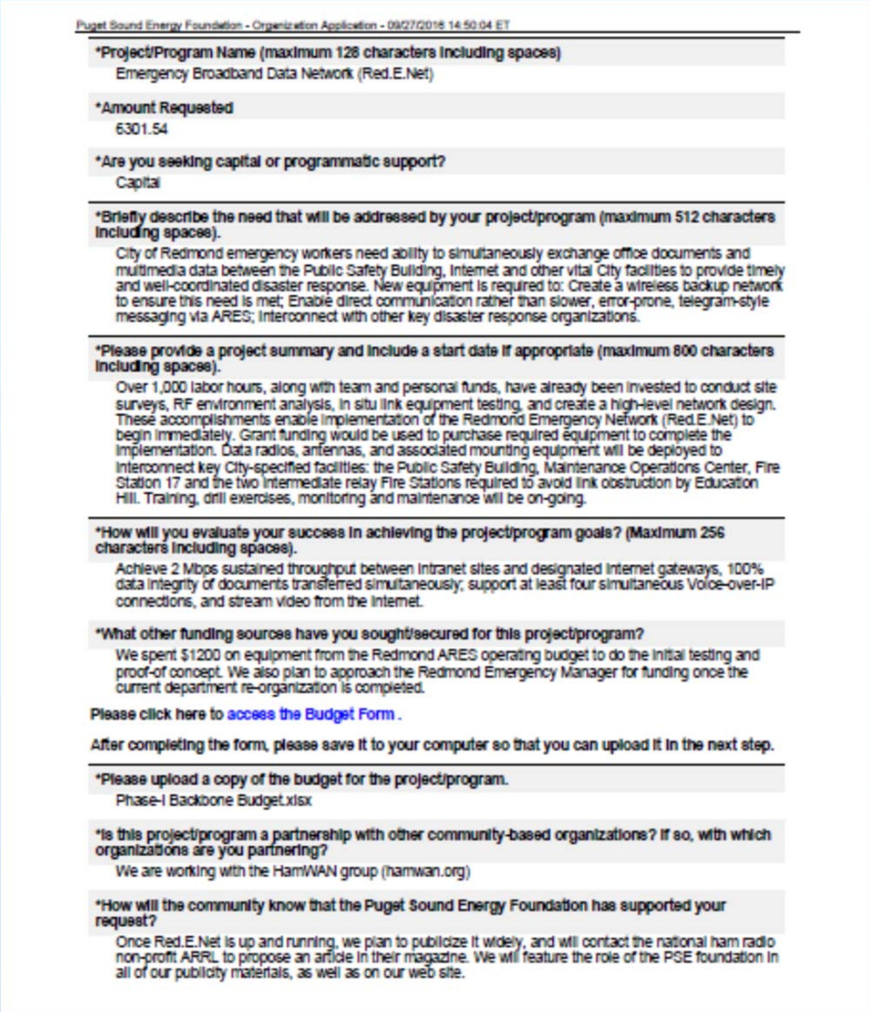
Results – 2.4 GHz

Activity	Result / Status
Set up VoIP phones	They work great! ☺ (On same LAN anyway…)
Played briefly with “Ham-only” channels (0, -1, -2) using routers with Atheros chipset	Fun! Not sure where it factors in, but it’s nice to say “I’ve done that!”
Created an iperf3 “server” for bandwidth testing	Works GREAT! Used a Raspberry Pi 3. Highly recommended. ☺

Goal	Notes
Get AP working at City Hall	Will be used for testing coverage and ad-hoc linking (such as with a portable tripod setup).
Try VoIP phones over radio link	Could be very useful.
Develop a relatively standard “field node” configuration (based on a member’s prototype).	This type of network equipment will be critical for ad-hoc network deployment. However, this is partly dependent on the architecture of the city-wide network.

PSE Grant Award

Redmond ARES received Red.E.Net program grant 12/9/2016



Puget Sound Energy Foundation - Organization Application - 09/27/2016 14:50:04 ET

***Project/Program Name (maximum 128 characters including spaces)**

Emergency Broadband Data Network (Red.E.Net)

***Amount Requested**

6301.54

***Are you seeking capital or programmatic support?**

Capital

***Briefly describe the need that will be addressed by your project/program (maximum 512 characters including spaces).**

City of Redmond emergency workers need ability to simultaneously exchange office documents and multimedia data between the Public Safety Building, Internet and other vital City facilities to provide timely and well-coordinated disaster response. New equipment is required to: Create a wireless backup network to ensure this need is met; Enable direct communication rather than slower, error-prone, telegram-style messaging via ARES; Interconnect with other key disaster response organizations.

***Please provide a project summary and include a start date if appropriate (maximum 800 characters including spaces).**

Over 1,000 labor hours, along with team and personal funds, have already been invested to conduct site surveys, RF environment analysis, in situ link equipment testing, and create a high-level network design. These accomplishments enable implementation of the Redmond Emergency Network (Red.E.Net) to begin immediately. Grant funding would be used to purchase required equipment to complete the implementation. Data radios, antennas, and associated mounting equipment will be deployed to interconnect key City-specified facilities: the Public Safety Building, Maintenance Operations Center, Fire Station 17 and the two intermediate relay Fire Stations required to avoid link obstruction by Education Hill. Training, drill exercises, monitoring and maintenance will be on-going.

***How will you evaluate your success in achieving the project/program goals? (Maximum 256 characters including spaces).**

Achieve 2 Mbps sustained throughput between intranet sites and designated Internet gateways, 100% data integrity of documents transferred simultaneously; support at least four simultaneous Voice-over-IP connections, and stream video from the Internet.

***What other funding sources have you sought/secured for this project/program?**

We spent $1200 on equipment from the Redmond ARES operating budget to do the initial testing and proof-of concept. We also plan to approach the Redmond Emergency Manager for funding once the current department re-organization is completed.

Please click here to access the Budget Form .

After completing the form, please save it to your computer so that you can upload it in the next step.

***Please upload a copy of the budget for the project/program.**

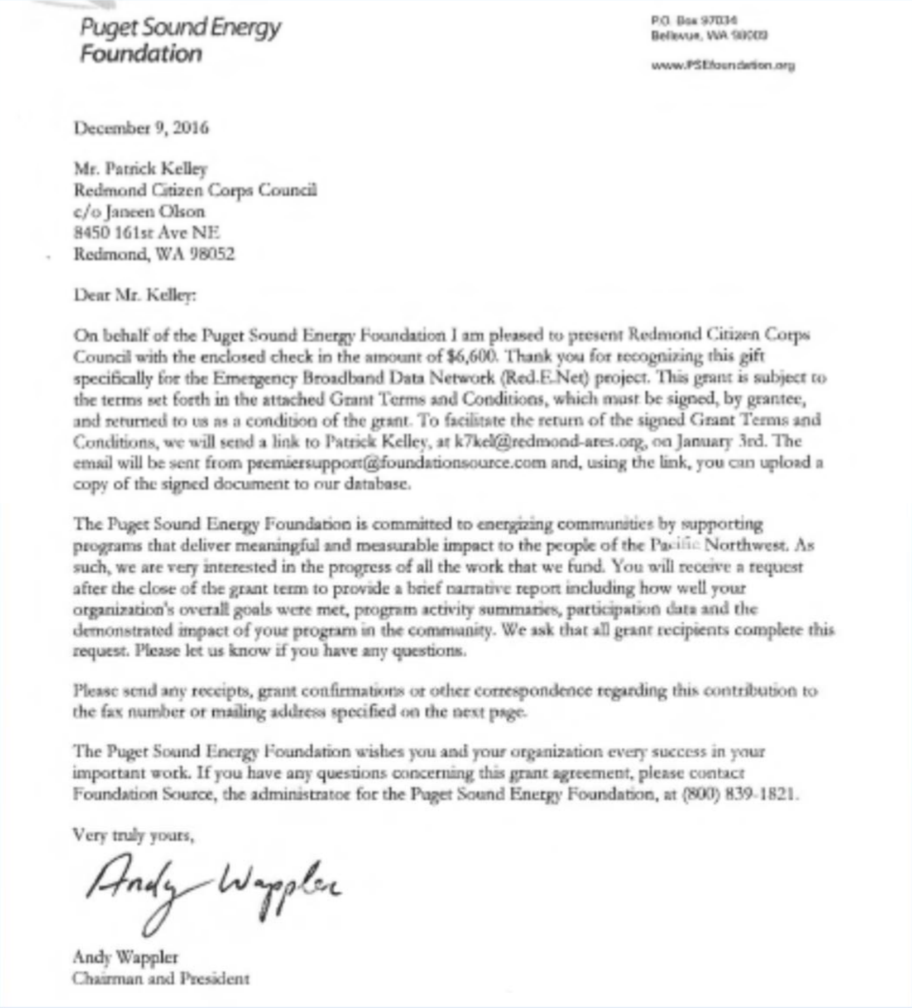
Phase-I Backbone Budget.xlsx

***Is this project/program a partnership with other community-based organizations? If so, with which organizations are you partnering?**

We are working with the HamWAN group (hamwan.org)

***How will the community know that the Puget Sound Energy Foundation has supported your request?**

Once Red.E.Net is up and running, we plan to publicize it widely, and will contact the national ham radio non-profit ARRL to propose an article in their magazine. We will feature the role of the PSE foundation in all of our publicity materials, as well as on our web site.



Puget Sound Energy
Foundation

P.O. Box 97034
Bellevue, WA 98009

www.PSEfoundation.org

December 9, 2016

Mr. Patrick Kelley
Redmond Citizen Corps Council
c/o Janeen Olson
8450 161st Ave NE
Redmond, WA 98052

Dear Mr. Kelley:

On behalf of the Puget Sound Energy Foundation I am pleased to present Redmond Citizen Corps Council with the enclosed check in the amount of $6,600. Thank you for recognizing this gift specifically for the Emergency Broadband Data Network (Red.E.Net) project. This grant is subject to the terms set forth in the attached Grant Terms and Conditions, which must be signed, by grantee, and returned to us as a condition of the grant. To facilitate the return of the signed Grant Terms and Conditions, we will send a link to Patrick Kelley, at k7kel@redmond-ares.org, on January 3rd. The email will be sent from premiersupport@foundationsource.com and, using the link, you can upload a copy of the signed document to our database.

The Puget Sound Energy Foundation is committed to energizing communities by supporting programs that deliver meaningful and measurable impact to the people of the Pacific Northwest. As such, we are very interested in the progress of all the work that we fund. You will receive a request after the close of the grant term to provide a brief narrative report including how well your organization's overall goals were met, program activity summaries, participation data and the demonstrated impact of your program in the community. We ask that all grant recipients complete this request. Please let us know if you have any questions.

Please send any receipts, grant confirmations or other correspondence regarding this contribution to the fax number or mailing address specified on the next page.

The Puget Sound Energy Foundation wishes you and your organization every success in your important work. If you have any questions concerning this grant agreement, please contact Foundation Source, the administrator for the Puget Sound Energy Foundation, at (800) 839-1821.

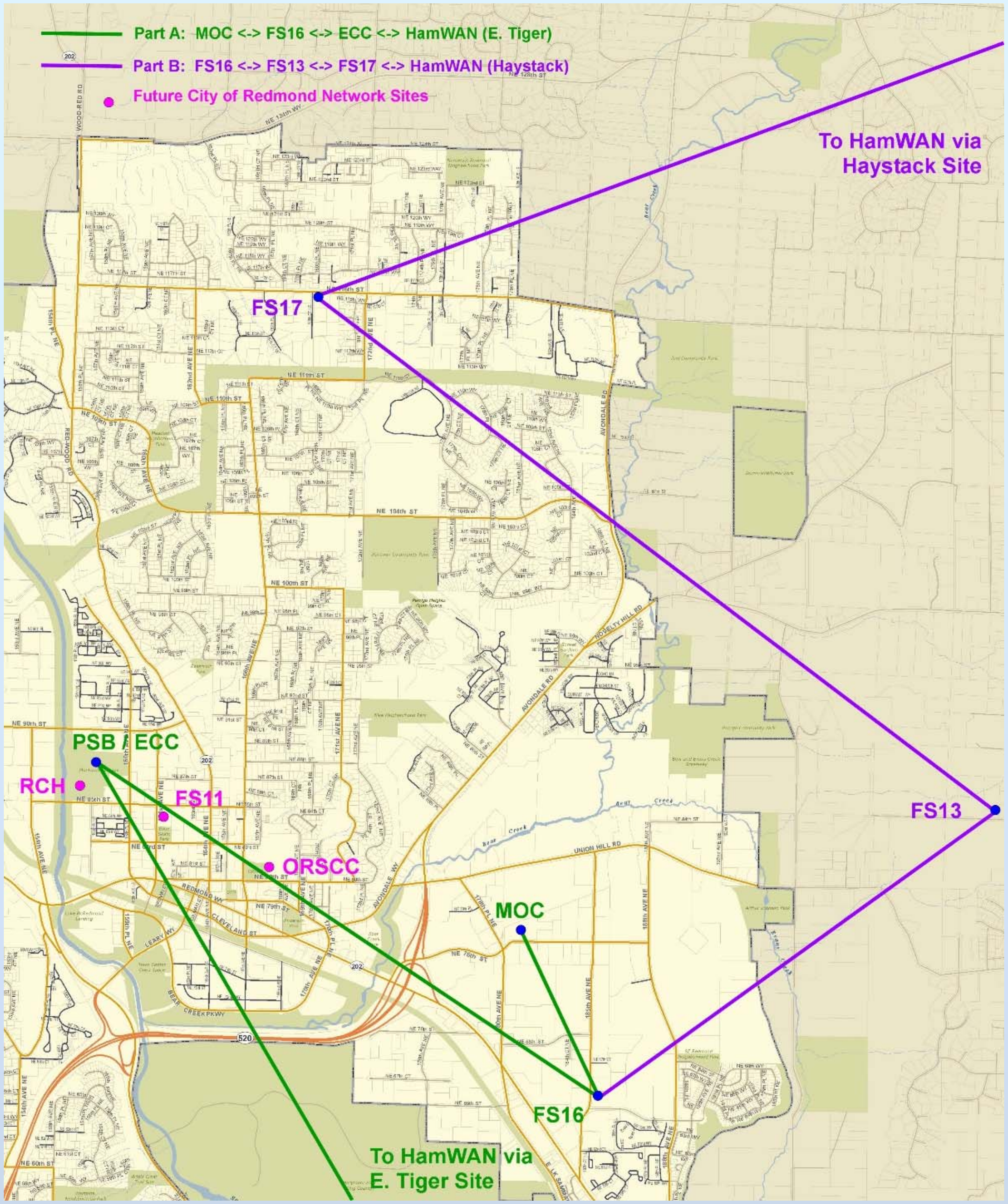
Very truly yours,

Andy Wappler

Andy Wappler
Chairman and President

Redmond ARES

Red.E.Net Phase 1


Part A: MOC <-> FS16 <-> ECC <-> HamWAN (E. Tiger)
Part B: FS16 <-> FS13 <-> FS17 <-> HamWAN (Haystack)
Future City of Redmond Network Sites
To HamWAN via Haystack Site
FS17
PSB / ECC
RCH
FS11
ORSCC
FS13
MOC
FS16
To HamWAN via E. Tiger Site

City of Redmond WASHINGTON

Red.E.Net Phase 1 Tasks

Area of Expertise	Associated Implementation Tasks	Notes
External Organization Relations	• City of Redmond Liaison • Neighbor city liaison(s) [future]	• Particularly with City facilities personnel
Site Requirements and Standards **Network Requirements and Standards**	• Standards & “Best Practices” research for installation and operation • Technical writing • Hands-on experience from which to draw upon for practical, appropriate and useful specifications for our environment and situations	• Need to be in a form that is both understandable and usable by team (reasonably plain language), professional, and acceptable to City facilities group
Outdoor hardware and cable installation	• Site surveys • Antenna placement survey • Antenna mount installation (or coordination with City contractor) • Microwave antenna installation & alignment (dish antennas) • Data radio configuration, end-to-end testing, and troubleshooting for signal optimization • Antenna cabling • Entrance cabling • Lightning protection • Weather protection • DC PoE	• Professional experience would be awesome, but prior experience with amateur installs at similar level of quality (at least for team lead) • Requires climbing ladders and moderate physical exertion.
Indoor hardware and cable installation	• Site surveys • Telco quality install • AC / DC power configuration, safety, and code considerations • Data cabling (including shielded data cable and transition from outdoor cabling) • Data connectors (including shielded connectors) • DC PoE	• Professional telco/data center installation experience (at least for the team lead) • Requires climbing ladders and moderate physical exertion.

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Red.E.Net Phase 1 Tasks

Area of Expertise	Associated Implementation Tasks	Notes
IP Network Design & Operation	• Network architecture (physical and logical / configuration) • Design considerations for application support (e.g. VoIP, file sharing, messaging, etc.) • Experience with physical LAN configuration and operation • Public Internet routing, ISP peering and associated gateway protocols (BGP, ASN's) • Experience with VLAN's (and related virtual features such as VRRP) • IP "tunneling" • Network equipment configuration and deployment (routers, managed switches, hubs, etc.) • Network diagnostics and troubleshooting • Network administration and monitoring (SNMP?) • HamWAN	
Wi-Fi Hotspot	• "Heat mapping" and network design • Design, configuration, deployment and operation • Multi-AP design and implementation	
VoIP **File Sharing** **Messaging** **E-mail / WinLink** **Server systems** **Collaboration** **Office productivity tools in a network environment** **HamWAN**	• Server implementation, administration and support • Application implementation and administration • Equipment configuration • Diagnostics and troubleshooting	

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Red.E.Net Phase 1 Timeline

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Tentative Project Timeline

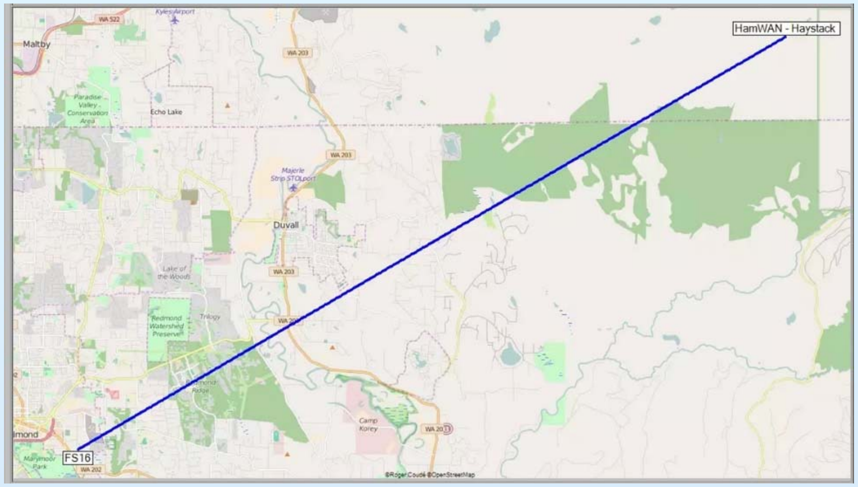
May: team assignments; site surveys; equipment procurement; research for installation best practices; facility siting approvals

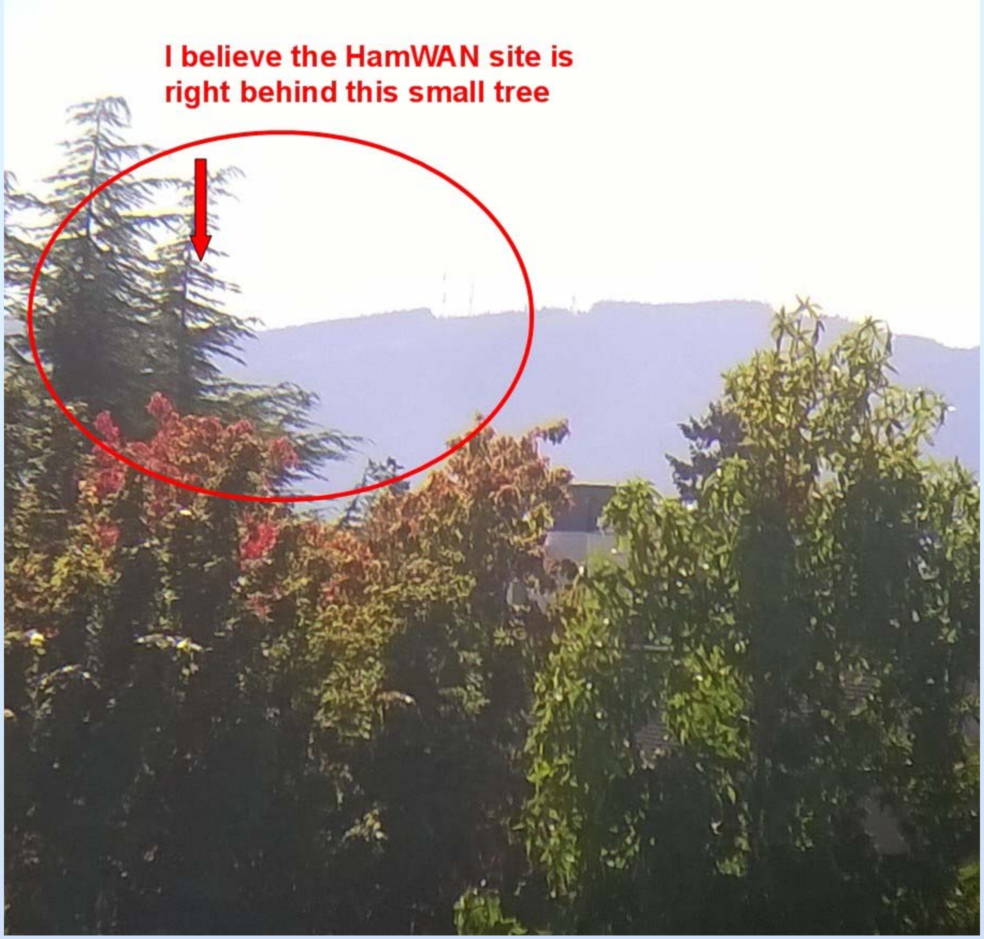
June-July: equipment assembly & configuration; cabling installation; antenna & dish installation; baseline network design complete

Aug-Sep: antenna alignments; link optimization; network routing configurations; AP router installation & configuration

Oct-Dec: VoIP & user apps configuration & testing; HamWAN link installation & testing

HamWAN Challenges

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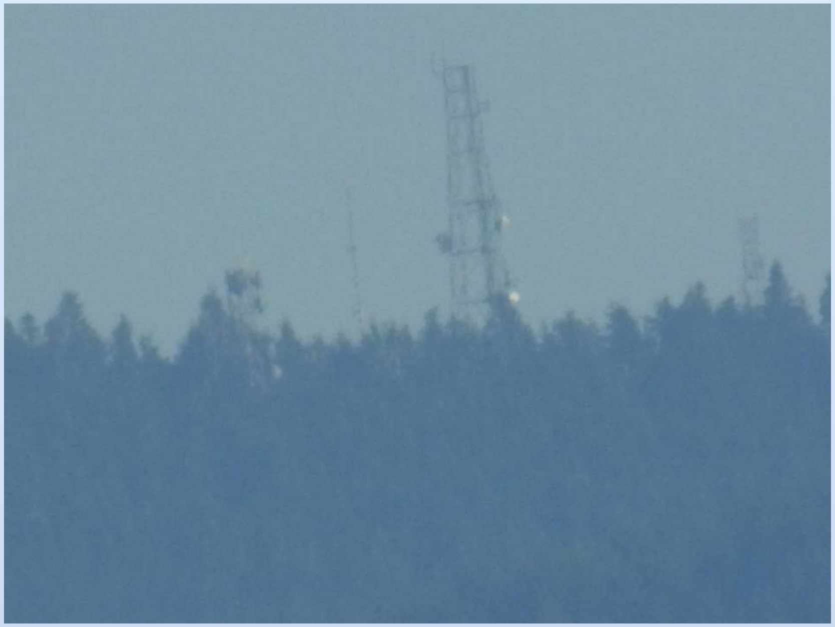

Questions?

Thank You!!